Using Animal-Borne Cameras to Quantify Prey Field, Habitat Characteristics and Foraging Success in a Marine Top Predator

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LONG-TERM GOALS

To understand the factors which influence population dynamics in marine mammals, and the potential risks anthropogenic activities pose, knowledge of their habitat use and the environmental factors determining foraging success is required. While over the last decade great advances have been made in this area for pelagic foraging species, such information is largely lacking for benthic foraging marine mammals. Therefore, the long term goals of this project are to determine in a model species (the Australian fur seal) the key ecological characteristics of their benthic foraging habitat, the profitability (prey captured *versus* effort) of various habitats and the spatial distribution of critical habitat. The techniques and principles developed in this project will be applicable for a variety of benthic foraging seal species world-wide and will contribute to our understanding of the role of top predators in shaping marine communities.

OBJECTIVES

The specific aims of the study are to:

1) quantify the prey fields encountered by adult female Australian fur seals in various habitats using video footage recorded on the seals;
2) determine seal movements at the fine-scale appropriate to prey encounters using GPS loggers and 3-axis accelerometers;
3) quantify net energy gain while foraging in different habitats; and
4) establish the habitat characteristics and individual factors that influence these parameters.

APPROACH

The aims of this study will be achieved through a conceptually simple, yet highly effective, methodological approach. Animal-borne video recording equipment will be combined with high resolution tracking to characterise and map the benthic habitats in which Australian fur seals forage and to determine the relative profitability of these habitats as measured by foraging success (prey consumption/energy expended).

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The study will be conducted on Kanowna Island, northern Bass Strait, which hosts a large breeding colony with an annual production of *ca*3000 pups. Individual adult females suckling pups will be selected at random, captured and instrumented with a digital video recorder data logger (Crittercam® V5.7, National Geographic Society, Washington, USA) encased in a water-proof aluminium housing (5 cm diameter, 25 cm length). The device will be glued to the dorsal fur along the mid-line posterior to the scapula using quick-setting epoxy (Fig. 1). The Crittercam is designed to record high resolution, wide angle, video footage in low ambient daytime light levels encountered at depths of up to 100 m and on-board red LED beams provide sufficient light to record video at night. To enable complete foraging trips (6-10 days) to be sub-sampled, the Crittercam will record video data on a duty-cycle of 1 h on:3 h off. In addition to storing video footage, data from on-board sensors (depth ± 0.5 m, 3-axis accelerometer ± 0.06 G, compass ± 1º) is recorded enabling accurate three-dimensional dive profiles to be reconstructed (Simpkins et al. 2001). From such profiles, linear distances travelled can be measured enabling the size of features along the sea floor to be calculated. As well as the Crittercam, a small VHF transmitter and a FastLoc GPS® data logger will also be attached to the animal to assist in relocating it at the colony for recapture and for recording at-sea movements, respectively. In total, all devices attached to the seals will represent <2% body mass and <1% cross-sectional surface area and, thus, negligible additional hydrodynamic drag (Wilson et al. 1986).

Fig.1: Adult female Australian fur seal (Arctocephalus pusillus doriferus) on Kanowna Island, northern Bass Strait, instrumented with a Crittercam® video data recorder, VHF transmitter and Fastloc GPS® logger.

To investigate potential individual factors influencing foraging behaviour, age and body size will be determined in the instrumented females. Once morphometric measurements have been collected and the animal has recovered from the anaesthesia, it will be released and left to forage for a single trip to sea before being recaptured and the devices removed by cutting the fur beneath them. Data from the loggers will be downloaded in the field onto portable computers and their batteries recharged so that they can be redeployed on additional animals.

Individual quality is known to contribute to intra-specific differences in foraging behaviour within pinnipeds with studies involving sample sizes of 40-60 individuals detecting differences in relation to morphology, physiological capacity and/or age (Baechler et al. 2002, Fowler et al. 2006). Inter-annual variation in the ocean currents within Bass Strait are also known to impact prey availability for Australian fur seals are likely to impact the foraging decisions of adult females. Consequently, in order to obtain representative estimates of habitat characteristics and prey field, and how these influence foraging behaviour and success, 40 individuals will be sampled in each of the three years of the study (120 in total).

In the laboratory, the at-sea movements of individuals instrumented with a Crittercam will be mapped using the data downloaded from the FastLoc GPS® logger concurrently deployed on them. The high accuracy of locations (± 10 m) and fast sampling interval (5 min) of these loggers, coupled with the 3-dimensional reconstruction of dive profiles using the accelerometer data, will enable foraging routes to be determined with very high resolution. The video recordings will then be analysed for the type, number and density (based on the length of foraging tracks) of prey encountered. The benthic habitats visited by seals will be categorised using the towed-video classification program developed for the Victorian Marine Habitat Mapping Program (Ierodiaconou et al. 2007). These analyses, which will be conducted with the assistance of Dr Daniel Ierodiaconou of Deakin University's Marine Habitat Mapping Facility, will enable statistical comparisons of prey fields, and capture rates, between various benthic habitat types.

WORK COMPLETED

Due to unforeseeable delays in obtaining Deakin University and BUMED clearance for animal use, this project did not commence until early February 2010. Administrative delays at Deakin University in obtaining the funds from ONR meant that production of the Crittercam video data loggers by National Geographic and the recruitment of the post-doctoral assistant were further set back. Consequently, due to the seasonal nature of the data collection, the first field season for the project started in late July and, at the time of writing this report, was still in progress.

To date, a total of 18 adult female Australian fur seals, covering a broad range in body size (Table 1), have been instrumented with Crittercams, dive behaviour recorders and GPS data loggers. Dive behaviour and GPS location data were successfully obtained from all individuals. Technical malfunctions in the Crittercams resulted in no or little video data being recorded during 6 deployments. Damage to the communications ports on a further 6 Crittercams during deployments meant that video data could not be retrieved in the field and the devices had to be sent back to the manufacturer for repair, interrogation and downloading (data from 4 devices could be retrieved). Consequently, these were not available for further deployments for the remainder of the field season which reduced the total number of individuals that could be sampled. Video data obtained from 10 deployments are currently being analysed.

RESULTS

Analysis of the video data for habitat classification, prey identification and measuring, and estimating energy expenditure is labour intensive and is currently only beginning for this project. Preliminary analyses, however, have revealed interesting findings.

So far, a high proportion of prey consumed by the instrumented animals appear to have been octopus and gurnard species. This is of significance because, while such prey have previously been recorded in the diet of Australian fur seals, they have been considered to be of minor importance. The discrepancy may result from the fact that cephalopod beaks are regularly regurgitated and, as revealed by the video data, the seals tend to vigorously shake gurnards upon capture (to break the heads off) before swallowing them (Fig. 2). Consequently, no identifiable remains of these species would be found in the seals' faeces. This has important implications for estimations of population prey consumption by Australian fur seals and their impact on the marine ecosystem.

Interestingly, the video data has shown that Australian fur seals use straight-line search paths on the sea floor. In addition to not conforming to most models of optimal foraging, this finding has implications for mapping foraging effort and habitat use in this, and potentially all benthic foraging, seal species. Evidence of ambush predation has also been observed with individuals spending up to 6 minutes motionless on the sea floor before commencing high speed chases and for capturing fish and octopus.

An unexpected finding is the use by some individuals of man-made underwater structures, such as gas pipelines, for foraging areas and navigational cues (Fig. 2). One individual followed a pipe-line for nearly 20 km. This potentially has significant implications for the impact of human activities on the relationship between top predators such as fur seals and the sea floor communities the depend on.

IMPACT/APPLICATIONS

The overall aim of the proposed research is to determine the factors which influence spatial and temporal foraging success in an important marine predator. In particular, by employing new biologging and telemetry technology we will be able to quantify three particularly elusive aspects of marine mammal foraging ecology: the prey field, foraging success and foraging costs. The project focuses on the Australia fur seal where this information is vital for predicting how the most significant marine predator biomass in south-eastern Australia, and its impact on the marine ecosystem, will respond to environmental variability. The project, however, has broader international significance in that it will contribute to our understanding of the role of top predators in shaping marine communities, which is of particular importance given anticipated global climate change and the world-wide ever-increasing human exploitation of marine resources.

This study has additional global significance as the underlying principals determining foraging success will be applicable for a variety of benthic foraging seal species whose populations are currently under threat and where the impacts of bottom/demersal trawls by commercial fisheries on their prey field are unknown. Furthermore, an important and novel spin-off from this research will be improved mapping of sea-floor characteristics in many parts of the world, for a range of uses (e.g. environmental assessment, ecosystem monitoring), on a scale not feasible using conventional methods (i.e. hydrographic surveys and benthic trawl sampling).

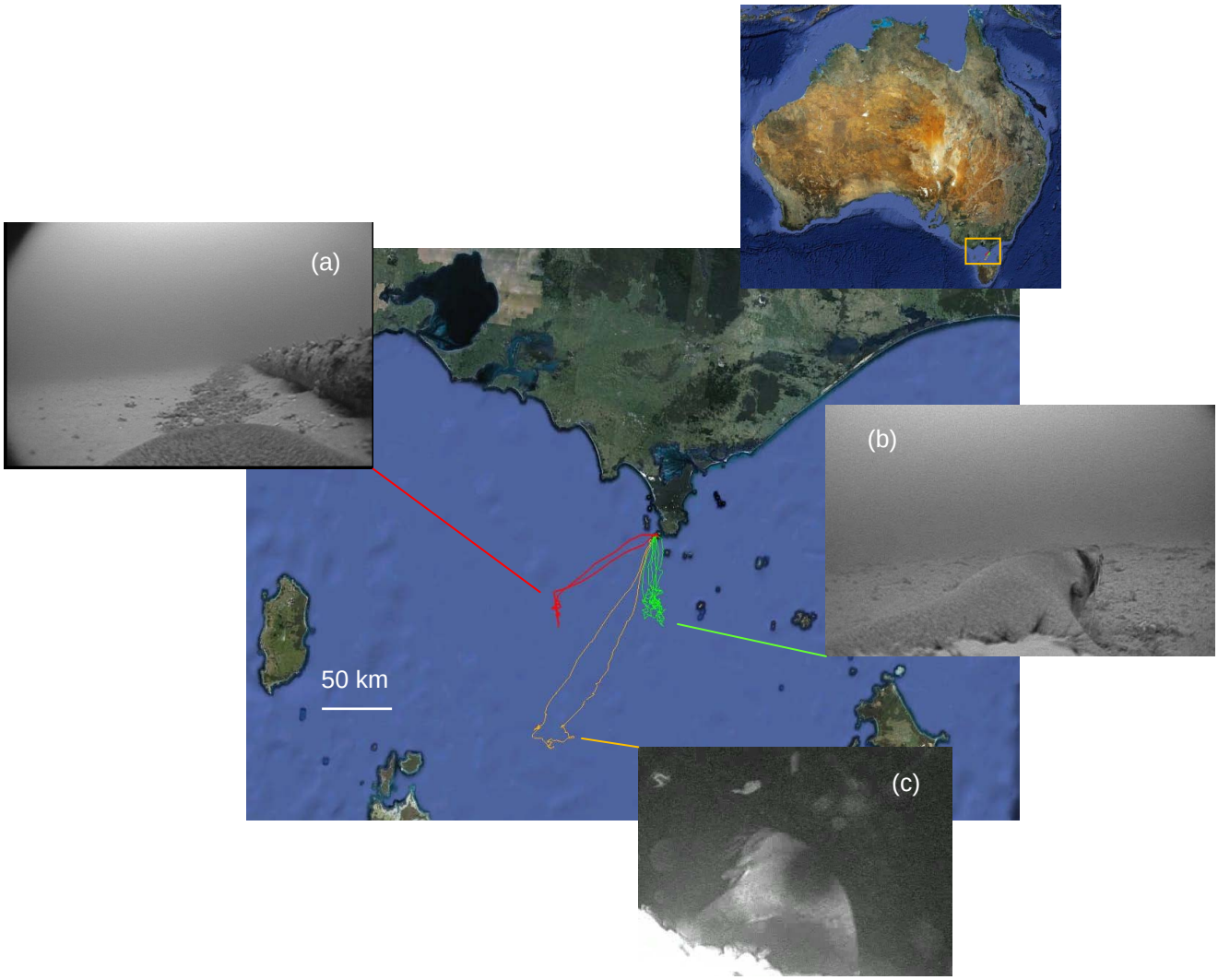

Fig. 2: Examples of foraging trip routes taken by three adult female Australian fur seals from Kanowna Island (northern Bass Strait) and representative data obtained by the Crittercam® video recorder they carried: a) foraging along a gas pipeline; b) motionless on sea floor in ambush mode; and c) chasing a gurnard at night.

RELATED PROJECTS

There are currently no projects directly related to the one being reported here.

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